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Development of an application for teaching pulmonary ultrasound in an emergency

Desenvolvimento de um aplicativo para ensino de ultrassonografia pulmonar em emergência

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ABSTRACT

Introduction: The use of ultrasound protocols has revolutionized care in emergency medicine and can help in the diagnosis of respiratory failure in emergency care; therefore, medical training for the use of these protocols has become important. It has also been demonstrated that medical smartphone apps have positive results in daily practice, in addition to being a potentially valuable educational tool.

Objective: Thus, the objective was to develop an emergency pulmonary ultrasound application. The "BLUE SIM" is a cell phone application that simulates clinical cases using the "Bedside Lung Ultrasound in Emergency" protocol, which can help students and health professionals regarding the use of pulmonary ultrasound in the care of acute respiratory failure. The hypothesis is that the "BLUE SIM" will be a usable and acceptable application among users.

Method: After the development, the application was evaluated with a group of 36 volunteers, which included 18 physical therapists and 18 other professionals consisting of physicians, nurses and medical students. The usability and usefulness of a mobile application for the iOS system was analyzed, using the System Utility Score (SUS) usability scale and the Technology Acceptance Model (TAM) as references. The obtained data were tabulated and analyzed using Fisher's exact test or Mann-Whitney test.

Result: When applying the SUS questionnaire (usability), the application obtained a score of 76.8%. A score of 75% was obtained exclusively among physical therapists, with no statistical difference between the general group of all emergency professionals and the group of physical therapists only (p=0.239). According to the usefulness perception analysis, 93.9% of the emergency professionals had a positive response, while a score of 88.9% was obtained among physical therapists (p=0.04).

Conclusion: It was concluded that the developed application was classified as useful in learning the diagnosis of respiratory failure among health professionals; however, they considered that training is necessary for its use.

Keywords: smartphones; teaching; ultrasonography.

RESUMO

Introdução: *A utilização de protocolos de ultrassonografia revolucionou o atendimento na medicina de emergência e pode auxiliar no diagnóstico de insuficiência respiratória no pronto atendimento. Assim, torna-se importante o treinamento médico para a utilização desses protocolos. Já foi demonstrado também que os aplicativos de smartphone médico têm resultados positivos na prática diária, além de serem uma ferramenta educacional potencialmente valiosa.*

Objetivo: *Dessa forma, o objetivo deste estudo foi desenvolver um aplicativo em ultrassonografia pulmonar de emergência. O BLUE SIM é um aplicativo de celular que simula atendimentos de casos clínicos utilizando o protocolo Bedside Lung Ultrasound in Emergency, o qual pode auxiliar alunos e profissionais da área da saúde a usar a ultrassonografia pulmonar no atendimento da insuficiência respiratória aguda. A hipótese é que o BLUE SIM será um aplicativo usável e aceitável entre os usuários.*

Método: *Após desenvolvido, avaliou-se o aplicativo com 36 voluntários: 18 fisioterapeutas, um médico, sete enfermeiros e dez acadêmicos de Medicina. Analisaram-se a usabilidade e a utilidade de uma aplicação móvel para o sistema iOS, utilizando como referências a escala de usabilidade System Utility Score (SUS) e o modelo de aceitação Technology Acceptance Model (TAM). Os dados obtidos foram tabulados e analisados pelo teste exato de Fisher ou Mann-Whitney.*

Resultado: *Pela aplicação do questionário SUS (usabilidade), o aplicativo obteve um escore de 76,8%. Exclusivamente entre os fisioterapeutas, obteve-se um escore de 75%, não havendo diferença estatística entre o grupo geral de todos os profissionais emergencistas e o grupo somente de fisioterapeutas (p = 0,239). Segundo a análise de percepção de utilidade, 93,9% dos profissionais emergencistas responderam positivamente, enquanto, entre os fisioterapeutas, obteve-se um escore de 88,9% (p = 0,04).*

Conclusão: *O aplicativo desenvolvido foi classificado de utilidade na aprendizagem do diagnóstico de insuficiência respiratória entre os profissionais, contudo eles consideraram que é necessário um treinamento para o uso da ferramenta.*

Palavras-chave: *Smartphones; Ensino; Ultrassonografia.*

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INTRODUCTION

Acute respiratory failure is the loss of the respiratory system capacity to maintain ventilation and/or oxygenation, with an acute onset. This is one of the biggest challenges for emergency and intensivist professionals in the health area[1].

The diagnosis of respiratory failure in the emergency department is suspected in the presence of respiratory distress signs, which is then confirmed through arterial blood gas analysis and pulse oximetry measurement. The etiology is evident in some cases after the anamnesis and physical examination. In other cases, even after obtaining patient history and performing an adequate physical examination, with arterial blood gas analysis, and chest X-ray, the diagnosis is unclear. Pulmonary ultrasound at the bedside has an important complementary role to the standard clinical examination in these cases[1,2].

The use of "Point-Of-Care" ultrasound (POCUS) protocols has revolutionized care in emergency medicine, since they are fast protocols that can be carried out at the bedside, where portable ultrasound devices generate high definition images, revealing organ structure and function. Clinical management involving the early use of POCUS accurately guides the diagnosis, significantly reduces the physicians' diagnostic uncertainty, and also changes resource management and utilization[2]. In this sense, the "BLUE" protocol created by Lichtenstein et al., in 2008[3], may prove to be effective in the rapid diagnosis of acute respiratory failure.

A recent study published in the journal "Critical Care Medicine" demonstrated that radiography has low sensitivity and reasonable specificity when compared to computed tomography in detecting pulmonary pathologies in critically-ill patients. It demonstrated that pulmonary ultrasound is superior to chest radiography regarding sensitivity and has similar specificity, thus being indicated as a first-line diagnostic tool in critically-ill patients[4].

Pulmonary ultrasound is a fast, reproducible, and easier-to-learn imaging modality, when compared to other ultrasound techniques. Pulmonary ultrasound reduces the patient's exposure to ionizing radiation and contributes to the safety of professionals, as it can be performed at the bedside, preventing intrahospital transport and possible contamination risks. Portable devices, some that fit in the white coat pocket, are used in daily practice as an extension of the clinical examination at the bedside. The ultrasonographic findings of patients that come to the emergency room with suspected COVID-19 infection allow isolation to be performed even before the RT-PCR (swab) result is obtained. In this scenario, the ultrasound examination has a higher sensitivity than the chest X-ray. In patients admitted to intensive care units, it is possible to use pulmonary ultrasound to monitor disease progression and observe the effects of changes in mechanical ventilation and alveolar recruitment maneuvers[5].

The use of pulmonary ultrasound has gained new importance with the advent of the COVID-19 pandemic, as it has shown to be a first-line diagnostic tool regarding patients with COVID-19. It has a sensitivity of 90.2% and specificity of 88.8% in pneumonia due to COVID-19[6].

Due to the COVID-19 pandemic and the need for social distancing, in-person classes were cancelled. Educators had to be creative and developed an alternative way of transmitting knowledge and teaching new psychomotor skills. Educational platforms are in constant evolution to meet this demand, with simulation, virtual reality and training via the internet in modules being frequently used.

Traditionally, POCUS training programs include several elements, such as theoretical sessions, hands-on practices and supervised exams[7].

Mobile technologies (cell phones and tablets) are revolutionizing the learning process. Currently, there are several relevant applications for these devices used in medical education[8]. The use of new teaching techniques in applications, such as "gamification" and simulation, are being increasingly incorporated.

The great transformations that have been taking place in medical education require that all aspects of medical practice be encompassed, namely: knowledge; expected skills and attitudes (standards of care). In this context, simulation has gained prominence, being a technique that can facilitate the cognitive, psychomotor and affective domains.

The use of the simulation technique allows increasing the professional's safety, since there is greater uniformity in training in a controlled teaching environment, preparing students with greater quality for everyday situations, even rare and unexpected events. The operator's experience and training in carrying out the procedure is decisive for the technical result, increasing the quality of patient care.

Currently, "phantoms" (dummies) or virtual high-cost simulators have been used in the simulation of pulmonary ultrasound. The hypothesis is that the "BLUE SIM" will be a usable and acceptable application among users. The "BLUE SIM" may allow a reduction in costs and a simplification in the structuring of training and courses. Therefore, the aim of the present study was to develop an application of situations in health simulation and evaluate its usability and acceptability among emergency care professionals.

MATERIALS AND METHODS

The study comprised an analytical, cross-sectional, descriptive and quantitative assessment. The first step

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consisted in the selection of the target audience and choosing the topics to be explored in the application. After approval by the Ethics Committee (4,311,354), the application, which simulates different clinical situations provided for in the "BLUE" protocol, was developed. The application was developed by professionals in the areas of emergency medicine, one of which was an evaluator of the app and from the computing area at the Department of Technological Innovation at Centro Universitário Christus/UNICHRISTUS. Application versions were developed for the Android and IOS mobile platform.

The application, called "BLUE SIM", proposes to simulate clinical case consultations using the "Bedside Lung Ultrasound in Emergency" protocol, which can help in the training of students and health professionals in the use of pulmonary ultrasound in the care of acute respiratory failure .

To use the application, after pressing the "enter" command on the cell phone screen, the user has the option of choosing one of the available cases. Each case includes: history, physical examination, laboratory tests, chest X-ray and pulmonary ultrasound images. The student, in a similar way to what is experienced with the use of cell phones that communicate with portable ultrasound devices, observes images of each case in the upper, lower and posterior windows. The analysis of the images is carried out with the study of the pleural line and the artifacts (A lines and B lines), thus arriving at the diagnosis of different clinical situations, such as: pulmonary edema; pneumonias; pleural effusions; pneumothorax and other causes of respiratory failure.

The user answers a "QUIZ" after viewing the ultrasonographic findings of each case. The questions help in clinical reasoning and follow the guidelines and flowchart of the "BLUE" protocol. The "QUIZ" evaluates the presence of pleural sliding, the occurrence of pathological B lines and the probable cause of respiratory failure. At the end of each case, a comment is available with a brief discussion of the ultrasonographic findings[9].

The next stage of the study consisted in determining the sample for the usability test. During the development of the application, it is recommended to carry out usability tests to identify possible problems in the interaction between the user and the interface, before its commercialization. Usability can be evaluated by standardizing its main attributes: the potential of the interface to be understood by the user ("effectiveness"), through easy navigation ("efficiency"), and that is friendly ("satisfaction") .

The sample for the usability and usefulness test consisted of 36 professionals, comprising 18 physical therapists, whereas the 18 others included 01 physician, 07 nurses and 10 medical students. All volunteers answered the questionnaire after completing the ultrasound training. The sample was chosen at random, reducing the research bias. The sample size was determined by the creators of the SUS scale and consists of twelve participants[10]. This study was conducted with a larger number of participants to minimize possible losses.

The volunteers used the application at their workplaces, individually, at the patient care location, in October 2021. The use of the application was conducted by the same evaluator aiming to minimize any biases that might interfere with the product final evaluation.

The next stage of the study consisted in conducting the usability test and the perception of usefulness. For this, an evaluation questionnaire based on existing questionnaires was used, which consists of four parts: Part 1, developed to obtain information regarding professional experiences and about the experience of each participant with emergency ultrasound; Part 2, based on the SUS questionnaire[11], validated in Portuguese in 2011[12], which aims to collect information about how easy it is to use the developed application (usability) and the hoe simple it is to learn how to use it (Ease of Learning); Part 3, based on Davis' Technology Acceptance Model (TAM)[13], aimed at identifying the level of usefulness of the system, perceived by users, i.e., perceived usefulness; Part 4, consisting of two subjective questions, which document the participants' opinions regarding the positive and negative points and suggestions for application improvements.

The usability test is characterized as an easy-to-apply method for investigating the usability of systems, where each question contains five response options that follow the 5-point Likert scale[14] (fully disagree, disagree, indifferent, agree and fully agree). The SUS scale is characterized as an easy-to-apply model for investigating the usability of systems[15].

To calculate the SUS, from the positively written answers (odd ones) 1 point was subtracted from the score and for the negatively written ones (even) 5 points were subtracted from the response value, and then the resulting scores were added and the value was multiplied by 2.5 to obtain the final score, which can range from 0 to 100. As stated by Sauro and Lewis (2012)[16], the SUS focuses on the analysis of two main system factors: usability and learning capacity[10].

For the TAM, the sum of the four answers was multiplied by 5 to obtain the final score, which can range from 0 to 100.

All tests were applied by two calibrated evaluators aiming to minimize any biases that could interfere with the final evaluation[17].

The final SUS and TAM scores were expressed as the mean and standard deviation of each item in the questionnaires using Fisher's or Mann-Whitney's exact test ($p<0.05$). The data were tabulated in Microsoft Excel and exported to the Statistical Package for the Social Sciences (SPSS) software, version 20.0 for Windows, adopting a confidence level of 95% and significance set at $p<0.05$.

RESULTS

Data analysis was performed based on the responses to the evaluation instrument. Gains associated with usability, ease of learning and the usefulness perceived by the participants regarding the use of "BLUE SIM" were analyzed in more details.

Table 1 shows a summary of the analysis of Part 2 of the evaluation questionnaire, which corresponds to questions based on the SUS scale, and Part 3, which corresponds to questions from the TAM questionnaire. The results demonstrate that the Blue Sim application received a usability evaluation (76.8%). These statistical values were calculated based on guidelines found in Sauro's book on the best practices for using the SUS[10].

When analyzing the scale of Bangor, Kortum and Miller (2009)[18] it has a strong interface validity for existing data, as a score of 70 points traditionally means approval, proposing a set of acceptability ranges that would help professionals to determine whether a score in the SUS indicates an acceptable interface or not. It can be observed that the "BLUE SIM" achieved a good level of usability, due to the fact that it was higher than the minimum acceptable usability score[18].

In the SUS questionnaire, the questions: "I found this app to be unnecessarily complex", and "I found the app too complicated to use" had low scores, increasing the final percentage of the SUS test among the participants.

According to Davis (1989)[13], the acceptance of an application is related to how easy it is to use and its usefulness. Part 2 of the evaluation instrument focused on the issue of usability and Part 3 is aimed at allowing the analysis of the

Table 1. SUS and TAM description

		Likert scale				
	Mean±SD	**1**	**2**	**3**	**4**	**5**
SUS	**76.81±9.27**					
I think I would like to use this app often.	4.50±0.65	0(0.0%)	0(0.0%)	1(2.8%)	15(41.7%)	20(55.6%)
I found this app to be unnecessarily complex.	1.97±0.51	5(13.9%)	27(75.0%)	4(11.1%)	0(0.0%)	0(0.0%)
I found the app easy to use	4.58±0.69	0(0.0%)	1(2.8%)	1(2.8%)	10(27.8%)	24(66.7%)
I think I would need support from a tech support to use this app	2.39±0.90	5(13.9%)	16(44.4%)	12(33.3%)	2(5.6%)	1(2.8%)
I found the app's several functions to be well integrated.	4.50±0.81	0(0.0%)	2(5.6%)	1(2.8%)	10(27.8%)	23(63.9%)
I thought there was a lot of inconsistency in the app	2.06±0.53	4(11.1%)	26(72.2%)	6(16.7%)	0(0.0%)	0(0.0%)
I imagine that most people can learn to use this app quickly.	4.56±0.69	0(0.0%)	1(2.8%)	1(2.8%)	11(30.6%)	23(63.9%)
I found the app too complicated to use	1.97±0.77	8(22.2%)	23(63.9%)	4(11.1%)	0(0.0%)	1(2.8%)
I felt very confident using this app.	4.25±0.91	1(2.8%)	1(2.8%)	2(5.6%)	16(44.4%)	16(44.4%)
I had to learn several things before I could start using this app.	3.28±1.11	1(2.8%)	10(27.8%)	8(22.2%)	12(33.3%)	5(13.9%)
TAM	**91.34±8.33**					
Training in the "BLUE" protocol will be more effective with the use of the "BLUE SIM" application	4.47±0.56	0(0.0%)	0(0.0%)	0(0.0%)	13(36.1%)	23(63.9%)
Using the "BLUE SIM" app allows better control when learning the "BLUE" protocol	4.58±0.60	0(0.0%)	0(0.0%)	1(2.8%)	17(47.2%)	18(50.0%)
The "BLUE SIM" application simulates clinical situations that are evidenced in clinical practice in the management of acute respiratory failure	4.58±0.50	0(0.0%)	0(0.0%)	1(2.8%)	13(36.1%)	22(61.1%)
Using the "BLUE SIM" app improves the quality of training	4.64±0.49	0(0.0%)	0(0.0%)	0(0.0%)	15(41.7%)	21(58.3%)

Data expressed as absolute frequency and percentage or mean and standard deviation.
Source: data from the study.

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app's usefulness perceived by the study participants. Unlike the SUS, the questions to assess perceived usefulness based on the Davis model can vary and there is no standard formula for obtaining a single average result for all questions. Therefore, studies that use the Davis model evaluate the questionnaires through comparative analysis of the mean values obtained for each question and the frequency of responses[15].

Table 1 also shows the mean values of the answers to the second part of the applied questionnaire. The questions showed high scores. The good results demonstrate the usefulness of the application perceived by the participants.

The sample was stratified and compared according to some of the criteria described in Table 2. Physical therapists constitute a stratified category, as they stand out at the forefront of the management of this type of patient. In Table 3, the Mann-Whitney statistical method was used to assess the significance between data.

Due to the sample quality, half of which consisted of physical therapists, a statistical division of the SUS and TAM scores was performed. The usability evaluation by the physical therapists was similar to the group of "non-physical therapists" (p=0.239). Regarding the TAM score, the group of physical therapists had a lower score, still considered of good acceptability, with a statistical difference with the "non-physical therapists" group (p=0.04).

Table 2 allows the description of the participants' professional characteristics, analyzing their experiences in emergency medicine and emergency ultrasound protocols

Table 2. Description of usability according to stratification by category

		SUS			TAM		
	Total	**<80**	**80+**	**p-value**	**<80**	**80+**	**p-value**
Total	**36 (100.0%)**	**20(55.6%)**	**16(44.4%)**		**9(25.0%)**	**27(75.0%)**	**-**
Physical therapist							
No	18(50.0%)	10(50.0%)	8(50.0%)	1.000[a]	3(33.3%)	15(55.6%)	0.433[a]
Yes	18(50.0%)	10(50.0%)	8(50.0%)		6(66.7%)	12(44.4%)	
How long have you had experience in Emergency Medicine?	2.14±3.75	1.71±1.87	2.69±5.28	0.443[b]	1.73±1.95	2.28±4.21	0.712[b]
Have you ever had any training in "Point of Care" ultrasonography protocols in undergraduate school?							
No	30(83.3%)	17(85.0%)	13(81.3%)	1.000[a]	7(77.8%)	23(85.2%)	0.627[a]
Yes	6(16.7%)	3(15.0%)	3(18.8%)		2(22.2%)	4(14.8%)	
Have you had any training in "Point of Care" ultrasonography protocols after graduation?							
No	33(91.7%)	20(100.0%)	13(81.3%)	0.078[a]	9(100.0%)	24(88.9%)	0.558[a]
Yes	3(8.3%)	0(0.0%)	3(18.8%)		0(0.0%)	3(11.1%)	
Have you had any advanced training in "Point of Care" ultrasonography protocols after graduation?							
No	35(97.2%)	20(100.0%)	15(93.8%)	0.444[a]	9(100.0%)	24(96.3%)	1.000[a]
Yes	1(2.8%)	0(0.0%)	1(6.3%)		0(0.0%)	1(3.7%)	
Do you use "Point of Care" ultrasonography protocols in your medical practice on a regular basis?							
No	34(94.4%)	20(100.0%)	14(87.5%)	0.190[a]	9(100.0%)	25(92.6%)	1.000[a]
Yes	2(5.6%)	0(0.0%)	2(12.5%)		0(0.0%)	2(7.4%)	

Source: data from the study.

Table 3. SUS and TAM analysis stratified into groups of physical therapists and non-physical therapists

	Physical therapist		
	No	**Yes**	**p-value**
SUS	78.61±5.02	75.00±12.04	0,239
TAM	93.89±8.50	88.89±7.58	0,044
Mann-Whitney test			

Source: data from the study.

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("Point-of-Care"). The group of "non-physical therapists" consisted of 10 medical students, 07 nurses and 01 physician.

Part 4 of the questionnaire consisted of two subjective questions, which document the participants' opinions regarding the positive and negative aspects and suggestions for the application's improvement. Twenty-five volunteers (69.44%) highlighted the easy handling of the application as a positive point, whereas eleven volunteers (30.55%) did not record any comments about the application's positive points. Only 02 volunteers (5.55%) pointed out the application's negative points: 01 volunteer mentioned the interface as a negative point and 01 volunteer reported lack of clarity in some ultrasound images. Four volunteers (11.11%) suggested the app's availability on the IOS platform as an improvement, as it was not yet available for testing at that time of the research. The other volunteers (88.88%) did not give any suggestions for improvement.

DISCUSSION

Lung ultrasound has become an important tool in the diagnostic evaluation of acute respiratory failure, and in the context of the Covid-19 pandemic, lung ultrasound has been used to assist in decision-making. One limitation is that it requires professionals with enough competence to ensure safe and diagnostic clinical evaluations and images. This raises a discussion on the role and use of lung ultrasound during and after the COVID-19 pandemic, and how an increase in education and training can be accomplished[19].

Thus, considering the pandemic scenario experienced two years ago, it was necessary to develop a teaching system in ultrasonography in the environment where patient care is provided. Point-of-care ultrasonography has become a ubiquitous diagnostic tool, and there has been a growing interest in teaching professionals. Sufficient theoretical and practical skills are prerequisites for integrating chest ultrasound into a clinical setting and using it as an adjunct tool in clinical decision-making. Recommendations on how to train professionals to perform ultrasound exams are debated, and simulation-based training can improve clinical performance. Simulation use helps reduce its learning curve for greater acceptance in clinical practice[20].

The vast majority of training is taking place through simulators. Situ-LaCasse et al., in 2021[21] evaluated physicians who used SonoSIM®, an online training module to acquire ultrasound images. The result of the study suggested that one can develop basic practical skills in image acquisition after reviewing online modules. Shah et al., in 2019[22] carried out a study in which an experimental group was introduced to two extra hours of ultrasound simulation practices, in relation to the control group, which attended only 7 hours of lectures on ultrasound physiology (the experimental group also participated in this lecture). The simulation group showed a statistically significant improvement in the physiology exam, improving from 54.1% to 75.3% ($P<0.01$).

A systematic review published this year concluded that although simulation provides a highly promising solution to the need for increased point-of-care ultrasound instruction, the widespread use of this simulation for this purpose may be limited by the financial costs of high-fidelity training equipment[23].

Approximately in the last 10 years, mobile devices, particularly mobile applications, have aimed to meet people's demands to access to information and knowledge. The possibility of breaking barriers of time and space allows increased communication[24]. These characteristics add strategic value to the new society living in the "Information Age"[25].

Therefore, our aim was to develop a teaching system in the application model, using an app that simulates clinical cases through filters superimposed on images sent by portable ultrasound devices, helping to train students and professionals from the health area in the management of acute respiratory failure. The application is an innovative tool for this purpose, and has advantages such as low cost, since the student/professional works on clinical cases present in the app, and easy availability, since it is used in smartphones.

Regarding the content quality, apps must, according to Happtique Health App Certification Standards[26]: (1) provide authorship information, including detailed information about the authors' affiliations and credentials, and any involvement of a medical professional in the preparation of the content; (2) list all references or sources of content; (3) fully disclose any app sponsorship or other commercial funding arrangements and potential conflicts of interest. These are the same essential criteria that rule how we compare the quality of online medical/health-related information resources and Websites in general. In the development of the "BLUE SIM" application, an attempt was made to follow this standard, producing a manual with authorship information and a list of information references, aiming to adapt to the proposed certification standard.

The good results of the application regarding the usability evaluation are highlighted. This term, usability, is a key idea in human-computer interaction. It is defined as the effectiveness, efficiency and satisfaction with which specific users achieve their goals in specific environments[26]. It can be observed that the "BLUE SIM" achieved a good level of usability, as its score was higher than the minimum acceptable usability score, which is 70 according to Bangor, Kortum and Miller (2009)[18].

However, the obtained usability score lower than 80% is directly related to the following questions: "I found this app to be unnecessarily complex"; "I think I would need support from a tech support to use this app"; "I found the app too complicated to use". Thus, margins of improvement in the system that are enforced by the participants' perceptions are considered necessary.

When analyzing the application's perception of usefulness, the Davis[13] model was used, aimed at identifying the system's level of usefulness, as perceived by users. This is a useful system that helps users to improve their performance when performing a job. For this author, usability is an important factor; however, if the user does not perceive the system's usefulness, they will not use it. Davis proposed a model that allows the quantification of the degree of usefulness perceived by the users of a given application: Davis's Technology Acceptance Model (TAM). Several studies have used the Davis's model to assess system acceptance[28,29].

Considering the factors that resulted in a good evaluation of the usefulness (Training in the "BLUE" protocol will be more effective with the use of the "BLUE SIM" application; "Using the "BLUE SIM" application allows better control when learning the "BLUE" protocol ; "Using the "BLUE SIM" app improves the quality of training"; "The "BLUE SIM" application simulates clinical situations that are evidenced in clinical practice in the management of acute respiratory failure") the application is established as an acceptable system. The difference in results is emphasized when separating the sample (separation of the physical therapists who comprised a separate group), in which the physical therapists showed 88.9% of positivity, while the general group showed 93.9% (p=0.04).

Following the analysis of usefulness and usability perception, the stratification and comparison of the sample was performed according to some criteria: "Have you had any basic training in "Point of Care" ultrasonography protocols after graduation?" "Have you had any advanced training in "Point of Care" ultrasonography protocols after graduation?" "Do you use "Point of Care" ultrasonography protocols in your medical practice on a regular basis?". More than 90% of the participants gave negative answers to these questions. Therefore, the participants possibly found it difficult and complex to use the application, since they do not use it or have not received this type of training. Moreover, these negative answers were higher among physical therapists, justifying the difference regarding the perception of acceptability compared to the analysis of the general group.

Once again, the importance of using ultrasound for clinical diagnosis at the Point-of-care is emphasized, making it necessary to teach/train professionals for a possible better conduction of the clinical case diagnosis. The time and place of use contributes to training.

CONCLUSION

The developed application is useful in situations where it is necessary to use ultrasound at the point-of-care, in an acceptable way, helping the professional in diagnostic decision-making, and can be used as a tool to further the teaching and learning processes.

AUTHORS' CONTRIBUTION

Erik Macedo: writing of the study project and manuscript, application creator and in charge of administering the tests. Paulo Goberlânio de Barros Silva: author of the manuscript and in charge of administering the tests. Edgar Marçal: application developer. Juliana Paiva Marques Lima Rolim: writing of the study project and the manuscript and supervising the tests. Marcelo Azeredo Terra: administering the tests.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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